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DEPARTMENT OF AGRICULTURE,
NEW SOUTH WALES.

SCIENCE BULLETIN, No. 2. May, 1911.

IMPERIAL BUREAU OF MYCOLOGY
28 JUN 1921

PESTS AND DISEASES OF THE COCONUT PALM.

By

WALTER W. FROGGATT, F.L.S.,
Government Entomologist.

Workers in the respective branches of Economic Science covered by this series of Science Bulletins will receive such of them as may be of use in their special branches of study upon application to the Under Secretary, Department of Agriculture, Sydney.

† 89663 SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.—1911.

No. of Copies Issued, 500.

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PLATE I.

Photo. from Walter H. Lucas.

New Coconut Palm Plantation, Logo, Gizo, Solomon Islands.

Palm under six years old in full bearing.

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Pests and Diseases of the Coconut Palm.

BY

WALTER W. FROGGATT, F.L.S., Government Entomologist.

THE most characteristic of all the trees in the tropics are the Coconut palms (*Cocos nucifera*), with their slender feathery fronds drooping so gracefully down from the crown of the slender stem, as they fringe the coast line of a low island, sometimes in the distance seeming to spring right out of the surrounding ocean, at other times shooting out above the tangled jungle on the hill-top into a cluster of delicate foliage against the sky-line. Every native village, old settlement, or trading station throughout the islands of the Pacific is marked out with a Coconut palm grove.

This palm has such a wide range east and west, on both sides of the equator, that no one can say which was its original home. The name *Cocos* is said to have been first given to this palm by those intrepid explorers, the Portuguese, and to be a contraction of their word *Macaco*—a monkey—on account of the resemblance of the three eyes on the end of the nut to a monkey's face.

It flourishes all over the West Indies and the tropical coast of Mexico and South America; in the Indian Ocean, from the banks of the Nile through India, Ceylon, the Malay Archipelago to New Guinea; and though not indigenous to Australia, it is now grown on the northern coasts of Queensland. All the islands of the tropical zone of the great Pacific carry Coconut palms, from the little reef-fringed coral island to the great, rugged islands of the Solomon, New Hebrides, and Samoan Groups.

Candolle considers that the original home of the Coconut palm was the Eastern Archipelago; and it is said to have been recorded as existing on the Asiatic Coast for the last 4,000 years. However, when the Spaniards invaded Mexico in 1526 it was well established on the Pacific Coast. Guppy, in his work, "Plant Dispersal" (p. 413), says:—

> The question of the antiquity of the Coconut palm in Polynesia was discussed at length by Seemann, but for various reasons we cannot be absolutely certain whether or not it is an older denizen of the Pacific Islands than the Polynesian. It is, however, to be inferred that it came originally from the home of the genus in America; perhaps a gift brought by the equatorial current from the new world to Asia.

Again, the same writer says:—

The Coconut palm has been carried round the world through the agency of man and the currents, while the home of the genus is America.

Some writers have argued that coconuts are never self-sown; that, carried by wind and tide, they never get beyond the salt water, and rot without germinating; that all the groves along the beaches have been planted by natives.

On the other hand, to again quote Dr. Guppy, who has been such a keen observer for many years among the Pacific Islands, "Plant Dispersal" (p. 436):—

I may here allude to the fact that the Coconut, whether brought down by a river or transported by a current, is able to germinate and establish itself when washed up on the Fijian beaches. White residents living for years in one locality were quite convinced that this frequently happens. One of them pointed out to me some newly-formed land at a river's mouth, not over two years old, on which were growing young plants, three or four feet high, of *Barringtonia speciosa*, *Calophylum inophyllum*, and several other plants, including young Coconut palms, all growing from fruits washed up by the waves, and, therefore, self-sown.

There are large native plantations in India and Ceylon. Sir Samuel Baker ("Eight Years in Ceylon") says:—

For upwards of 129 miles along the western and southern coasts of Ceylon, one continuous line of Coconut groves wave their green leaves to the sea breeze without a single break, except where some broad, clean river cleaves the line of verdure as it meets the sea.

Ferguson estimates that there are 50,000,000 Coconut palms cultivated in Ceylon, covering over 650,000 acres, all of which, with the exception of a few thousand acres, are in the hands of natives, and the export value and home consumption he puts down at £2,500,000.

Along the Malabar and Coromandel coasts of India there are large areas devoted to the Coconut palm.

Wallace (Malay Archipelago) has many references to the value of the Coconut in that part of the world. Speaking of the Matabello Islands, he says:—

The natives of Matabello are almost entirely occupied in making Coconut oil, which they sell to the Bugos and Goram traders, who carry it to Banda and Amboyna. The rugged coral rocks seem very favourable to the growth of the Coconut palm, which abounds over the whole island to the very highest points, and produces fruit all the year round.

Again, speaking of the Kee Islands:—

From the Coconuts which surround every hut, and which thrive exceedingly on the porous limestone soil and under the influence of sea breezes, oil is made which is sold at a good price to the Aru traders, who all touch here to lay in their stock of the article, as well as to purchases boats and native crockery.

Another great area of Coconut palms is in Brazil, along the coast from the mouth of the San Francisco River to the bar of the Mamanguape, a distance of 280 miles, in an unbroken grove.

In Cuba, Jamaica, and most of the West Indian Islands, Coconut palms are grown, and the nuts are largely used for food, while the surplus is exported to England and the United States.

Within the last few years the great demand for Coconut oil has caused a large development of Coconut palm plantation on commercial lines. In Fiji, Samoa, New Hebrides, the Solomon Islands, New Guinea, and New Britain, large areas of forest have been cleared and the ground planted with Coconuts, which will be cultivated on scientific principles, with the latest methods for the production and preparation of copra.

Up to the last few years the chief supply of copra was, and much is still, collected by the traders from the natives of the Islands, who now, under the keen competition that has sprung up, know the value of Coconuts. Many of these groves are held in common by the village; in others, each man or family has the ground around his particular tree marked off, each claiming the nuts that fall upon his plot of ground.

The Coconut palm, besides being a thing of beauty even among the palms, "a prince among trees" Wallace says, "furnishes many thousands of the human race with food, drink, and shelter." A cup of clear water; cream from the pressed kernels; toddy to the early riser; arrack to the hardened drinker; sugar from the evaporated toddy, and a cup of oil; cabbage from the crown of the undeveloped leaves; domestic utensils; building material; boats, twine, mats, and rude clothing, are some of the native products of the palm enumerated by different writers.

Among the manufactured products we have desiccated Coconut, largely used in confectionery; Coconut oil, oilcake from the oil—extracted copra used for cattle food; coir rope, twine, and matting—the latter chiefly manufactured in India and Ceylon from the fibre of the husk of the nut.

Before dealing with the pests of the Coconut palm, I propose to give a brief account of the structure of the tree and its growth, so that the damage caused by insect pests and other diseases to the different parts of the palm can be more readily understood.

The Nut.

The ripe Coconut consists of a thick brown husk or outer covering of closely-matted brown vegetable fibre, full of air cells, so that, impervious to water, it makes the enclosed nut so buoyant that it floats on the surface of the water. This outer husk is the coir of commerce. Stripped from the Coconut, it is fermented in pits, and then cleaned and dried for rope and mat making. Within this compact fibre is the hard, brown Coconut, oval in form, consisting of a hard, brittle shell about one-eighth of an inch in thickness. At the larger end are the three brown scars—the "monkey-face"—two of which are simply depressions on the shell, but the third is the aperture (now coated with the hard kernel) through which, when it germinates, the leaf and root buds will push their way out and develop into a young palm. Within, and closely attached to the hard shell by a brown skin, is the compact white kernel or meat, about ½ inch in thickness when the nut is ripe, but soft and jelly-like in the immature nut. This kernel or meat is the copra of commerce. When ripe the nuts are collected, and either husked first or simply split into halves with an axe and the kernel removed

Photo. lent by G. Fulton, Levers' Pacific Plantations Co.

Coconut Nursery, Ceylon.

with a knife, broken up into pieces, and dried. An active man will clean 400 nuts in a day's work, and about 6,000 Coconuts will make a ton of dried copra. Within the kernel of the Coconut is the coconut milk and the embryo. The latter, feeding upon the milk, swells into a soft, sponge-like white substance, occupying the whole of the cavity; from this is produced the buds that make their way through the eye-hole in the shell into the ground and air.

The Young Palm.

The seed Coconut, selected on account of its size and shape, is placed in the nursery in a shallow hole, about half burying the nut. Within a very short time the leaf-bud emerges and turns upwards, and the root-bud turns downwards into the soil. When the young palms are well established the nuts are lifted and removed to the holes that have been marked off and dug in regular lines, from 27 to 30 feet apart either way. Within the first year the bud has developed into several circles of great pinnate, drooping fronds surrounding the main central bud, while the basal portion forms the butt of the future tree. Within three years the young palms have attained a height of 10 feet, with a well-defined stem of several feet in height; the old fronds of the first leaves rest on the ground, and the others spread round the young foliage, with the central bud just unfolding and crowning the summit of the palm. The old leaf-fronds are never cut off, for if this is done the contraction of the tissue in drying causes the butt of the leaf to split down the centre, and the crack will extend into the surface of the stem beneath, and will be a lodging place for damp, spores, and insect larvæ. As they dry off in the course of time the butts of the fronds are pushed off by the smooth, hard surface of the stem beneath, and a perfectly smooth cylindrical stem is developed as the palm grows upwards.

The Fruit.

Sometimes, at the third year, but more generally at the fourth, the flower spathes are developed. They push out from the side of the crown between the bases of the leaf stalks. These flower spathes consist of leaf-like scabbards of stiff brown tissue. Each one splits down the centre, when the baby spikelets they have unfolded, open out, each side of the finger-like processes being fringed with the male and female flowers. The male flowers are a mass of short, stiff, yellow flower-capsules, opening out into stiff petals enclosing a great quantity of dry, yellow, flour-like pollen, which is blown by the wind on the small globular female embryos (the baby Coconuts) that are produced upon the side of other spikelets. These, as they develop, form clusters of from ten to twenty Coconuts, at first pale green, with the shell beneath soft and easily cut, but as they mature they turn brown, and when ripe become detached at the base and fall to the ground; so that there is no work required to gather the nuts off the trees, because the crop is harvested from the ground. A Coconut palm in full bearing will, under natural conditions, keep bearing, with more or less regularity, for fifty to sixty years.

Scientific cultivation, manuring, and selection of the best nuts will soon show if it will not pay to force a larger crops of nuts from the trees while they are in their prime, and as soon as they show signs of falling off cut them and keep replanting.

In dealing with the insect and fungus pests we must remember the peculiar structure of the palm, so different from the ordinary fruit tree. If one branch of a fruit tree is cut off, or a bud broken out, it can continue to grow from a dozen different points, but the whole life of the palm tree is dependent upon the terminal leaf-bud, any injury to which endangers the life of the tree. As long as the leaf-bud remains healthy the tree continues to grow and to throw out fresh fronds.

Though the Coconut palm is such a hardy tree, and almost insect and fungus proof when it has a well-developed stem, it has a good many enemies to contend with in the first few years of its life, some of which are cosmopolitan in their range, others very local.

I propose in this paper to notice all insect and fungus pests that have been recorded as damaging Coconut palms.

Though Coconuts will never be grown in any quantity on the mainland of Australia, our interests are bound up with the plantations of New Guinea and the Pacific Islands, because the raw products are brought thence into the warehouses of Sydney, and will probably, in the near future, be all treated and prepared in the factories of the Commonwealth, and the finished commercial products be turned out in Australia.

As vegetable oils are being used more every year in the manufacture of soap, and the oil obtained from the compressed kernel (copra) of the Coconut is found to be one of the best for this purpose, the demand for copra by the soap-makers is always on the increase. After the oil is extracted there is always a market for the residue, which, pressed into solid slabs, is used for fattening calves and for feeding dairy stock. Therefore, the growing of Coconut palms will always be an important and profitable branch of tropical agriculture wherever there is suitable land for their cultivation, and for many years ahead the demand should more than equal the supply.

The Coconut Stag Beetle.

(*Eurytrachelus pilosipes*, Waterhouse.)

—Trans. Entom. Society, London, 1883, p. 447.

There is no record of any species of the *Lucanidæ*, or Stag Beetles, damaging Coconut palms, as far as I am aware, in other parts of the world; yet in the Solomon Island plantations this handsome stag beetle is a very serious pest, and does a great deal of damage to the young Coconut palms by boring into the stem under the shelter of the base of the leaf-stalk. To distinguish it from the larger Elephant Beetle, it is locally known as the "Small Borer."

Upon some of the smaller islands of the Russell Group, where clearing and burning off of the natural forest was going on, and probably their natural food was being destroyed in a wholesale manner, the natives were paid in

Photo. lent by G. Fulton, Levers' Pacific Plantations Co.

Young Plantation of Coconut Palms, Ceylon.

tobacco for all the beetles they brought in, and over 3,000 were collected and brought in during the month of May on the Island of Ufa. I was told that the natives found many of them early in the morning upon the Papaw trees.

Both sexes of this beetle are very variable in size, and in the form of the projecting horns. The largest males measure up to 1½ inch in length from the tip of the jaws to the hind margin of the body, while the corresponding females, with the short horns curved over the jaws, do not measure more than an inch. The head and thorax, fitting close together with a curving suture, are very broad and somewhat flattened. Taken together, they are almost as broad as long, and form an irregular square with the sides of the apical and basal portions slightly rounded. The small oval eyes are situated in front of the side of the head, and do not project. The mandibles, or horns, stand out in front, and are smooth on the inner edges at the base, swelling out and possessing a number of blunt teeth, and curving round at the tips. The wing-covers are proportionately small, straight (truncate) behind the apex of thorax, and quite as broad and rounded on the sides to the apex, shield-shaped. The female is much smaller, the head and thorax combined much shorter than the abdomen, the head coarsely and thickly punctured, the shortened, aborted mandibles curving over each other in front of the head. So much do they differ in size and shape that one might think that there were several species of this fine Stag Beetle, unless there were a large series showing all the gradations of size and shape of the mandibles.

From our knowledge of the Staghorn Beetle it is very probable that, under natural conditions, this species has much the same habits as others of the family, and that they feed upon dead or dying plant tissue, so that when all the land is cleared and the fallen timber destroyed, this pest will also vanish, or at most do little damage.

This beetle was described by C. O. Waterhouse in the "Transactions of the Entomological Society of London," page 447, and figured in plate XXI, Fig. 3. He says:—"Habitat, Santa Anna Island, Solomon Islands. . . . Two specimens collected by H. P. Guppy, Esq., and now presented to the British Museum."

The Solomon Island Elephant Beetle.

(*Xylotrupes nimrod*, Voet.)

This large lamellicorn beetle takes the place of the Rhinoceros Beetle of Ceylon and India, and has a wide range over the coastal districts of New Guinea, the Malay Archipelago, New Ireland, the Solomon Islands, and other of the adjacent groups. It is very variable in size, and also in the form of the prolongation of the head and thorax into those remarkable horns from which it obtains its popular name of Elephant Beetle.

The large male beetles, with the immense prolongation of the head and thorax, measure up to 3 inches in length from the tip of the projecting horn to the extremity of the abdomen; the females, with their more regularly rounded thorax and small head, seldom more than 2 inches, though 1½ inch across the centre of the body.

The general colour is deep brownish black to chocolate brown, with reddish hairs. The male has the front of the head produced into a stout cylindrical horn, curving upward and outward, with the extremity divided into finger-like processes; the front of the thorax is produced into a much larger similar process, turning downward in a line with the tip of the horn of the head. These projecting processes are very variable, both in length and shape; in the largest specimens the thoracic horn is often an inch in length. The

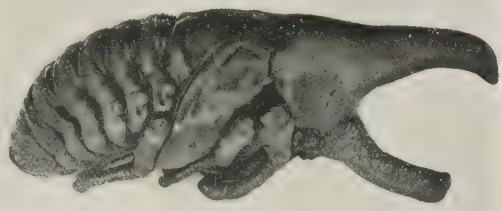


Fig. 1.
Pupa of Solomon Islands Beetle.
Xylotrupes nimrod, Voet.

jaws, with which all the damage is done, are hidden on the underside of the head, with the folded antennæ and palpi. The exact breeding place of the larvæ, or where the female deposits her eggs, is unknown; but I obtained specimens of a large lamellicorn larva in a rotten stump at the Solomons, and we know that the Queensland species has similar habits to that of the Indian species, so that rich loamy soil or rotten tree trunks and stumps are the natural home of this palm beetle, and the same methods adopted for destroying the Stag Beetle should be effective for this beetle.

Fig. 2.
Side View, Solomon Islands Elephant Beetle.
Xylotrupes nimrod (var.), Voet.

This beetle has always been more or less a pest in the Islands, and it is a very common thing to see the distinct keyhole-like mark on the trunk of an old palm tree in the native plantations, showing where the tree had once been damaged by this borer and had afterwards recovered. The beetle bores into the base of the leaf-stalk and thence into the base of the crown of the palm, where, if not noticed in time, it will often kill the terminal bud and destroy the tree.

Photo. lent by G. Fulton, Levers' Pacific Plantations Co.

Coconut Plantation in full bearing, Ceylon.

The plantation managers offer a reward for every beetle caught on a palm, and the natives soon become very expert in getting these out of their burrows without damaging the tree. The natives, however, bring in quite a number of harmless beetles, or at least beetles that do not damage the palm; these the managers pay for also, as they do not wish the boys to be discouraged, or they would soon stop collecting. On the new plantations, where clearing and burning off is going on, many large longicorn and other beetles are always to be found.

There are considerable variations in the form of the head and thorax of the males of *Xylotrupes nimrod* in a large series. The typical one described, and a well-defined variety in which the beetle is smaller and the projecting thoracic horn short and blunt at the tip, and the horn of the head proportionately smaller but forked at the extremity, are the two commonest forms.

Fig. 3.—Side View, Solomon Islands Elephant Beetle.
Xylotrupes nimrod (male).

In Gemminger and Harold's Catalogue, *Xylotrupes nimrod* is given as a synonym of *Xylotrupes gideon*, Linn., which has a wide range from Java through the Malay Archipelago.

The Queensland Elephant Beetle (*Xylotrupes australicus*), though very common about the Queensland sugar plantations, where, in old days, they used to breed in the rotting megass, have never been recorded as damaging trees.

We might be able to find some shrub or tree that would attract the beetles when they emerge and are pairing, and plant them about the Coconut groves to act as traps, where the resting beetles could be collected and destroyed. When on some of the North Queensland sugar plantations, some years ago, the writer found that the closely-allied Queensland Elephant Beetle (*Xylotrupes australicus*), with almost identical habits, was very fond of the Jacaranda tree—a South American tree—often grown in Australian gardens as an ornamental shade tree, on account of its delicate green foliage and clusters of pale blue flowers. Wherever one of these trees was planted round the manager's homestead they were always infested during the season with

PLATE V.

Original.

Dorsal View of Coconut Palm Beetles.

1, 2. Solomon Islands Elephant Beetle. *Xylotrupes nimrod*, Voet.
3, 4. Solomon Islands Elephant Beetle. *Xylotrupes nimrod* (variety).
5, 6. Solomon Islands Rhinoceros Beetle. *Trichogomphus semilinki*, Ritz

these large beetles. During my recent visit to the Solomon Islands I was informed by the manager at Gavutu that the Elephant Beetles were always to be found during the summer months upon the trunk and branches of a Jacaranda tree growing in front of his window. If it is found that this tree is attractive to the Solomon Island beetles in all localities it would be a simple method of collecting them.

The Solomon Island Rhinoceros Beetle.

(*Trichogomphus semilinki*, Ritz.)

This large lamellicorn beetle has been forwarded to me from the Solomon Islands, with the information that it damages the young Coconut palms in the same manner as *Xylotrupes nimrod.*

Fig. 4.
Side View, Solomon Islands Rhinoceros Beetle.
Trichogomphus semilinki, Ritz.

Of the same dark brown to blackish tint, and somewhat about the same size, it is much more like the Rhinoceros Beetle of Ceylon, as it has the front of the thorax deeply excavated, and the slender, erect horn on the head rising upward and curving backward.

The Rhinoceros Palm Beetle.

(*Oryctes rhinoceros*, Linn.)

This large lamellicorn beetle is a well known pest in India and Ceylon to a number of different species of palms, and particularly the Coconut palm. It has, however, a much wider range, being common in Java, according to Dr. Koningsberger, where it is one of the most destructive enemies of the Coconut palm. Banks says it is just as troublesome all over the Philippine Islands, and records it from Celebes, Borneo, and Sumatra.

Maxwell-Lefroy says ("Indian Insect Life"):—

> The beetle flies by night, and eats into the soft tissue of the growing palms. Eating through the developing leaves, it make tunnels, which are shown by ragged holes in the leaves when they open. Frequently the growing bud of the palm dies, growth is stopped, and the palm withers.

The eggs, he says, are laid in the soil at the commencement of the rains (June-July), the larvæ mature in September, pupate, and the perfect beetle emerges in October, but remains in the soil until May, when it comes out to feed.

Stebbing says:—

The common date and Coconut palm borer of Southern India. Its grubs have been reported as feeding upon the roots of young *Casuarina* seedlings and other trees.

Tennant ("Natural History of Ceylon") says:—

The larva of *Oryctes rhinoceros* does the damage to the young Coconut palms. The Singhalese call it Gascoorminga, and the Malabar natives eat the big fat grubs. Tennant appears to have confounded the red palm weevil with the rhinoceros beetle in regard to their larval habits.

Capper ("Journal of the Asiatic Society of Ceylon"), writing in 1845, says that he had recently passed through several Coconut plantations, varying in extent from 20 to 150 acres of 2 and 3 year old trees, and could not find a single young tree untouched by the Cooroominiga.

Banks, in his "Principal Insects attacking the Coconut Palm," gives a great deal of interesting information about this pest and the damage it causes in the Philippine Islands. He points out that this beetle always attacks the tree at the crown, and any holes seen in the stem are old scars of former attacks which the tree has outgrown. The larvæ are sometimes

Fig. 5.
Side View, Rhinoceros Beetle of Ceylon.
Oryctes rhinoceros, Lind.

found in the decaying tops of the dead or dying palms, and often in the dead trunks of standing or fallen trees, as many as a hundred grubs having been taken from the trunk of such a tree, in which all the central decayed portion had been reduced through their presence to a manure-like material. The natural place for the Rhinoceros Beetle to lay her eggs is in the soil, decaying refuse, vegetable matter, dead stumps, and such-like material.

From dissection, Banks thinks that the female Rhinoceros Beetle probably deposits about twenty-four eggs during her life. The larva is of the typical lamellicorn beetle form, large, rounded, wrinkled; a fat, white grub, about 4 inches in length, with a reddish, horny head and three pairs of small legs, the tip of the body broadly rounded with a few scattered stiff hairs, and when at rest it has the body curved round towards the underside of the head. When full-fed the grub pupates, and either constructs an oval cocoon composed of the materials upon which it has been feeding, or simply pupates in an oval cavity among the earthy mould.

The beetles are shining dark brown to almost black in colour, measuring up to 2 inches in length, the female somewhat smaller than the male. The male is furnished with a prominent horn, produced from the back of the head, which curves backward; the centre of the thorax is roughly hollowed

out behind, with a smaller horn on either side. The legs are stout, and covered with large spines adapted for digging. The wing-covers are smooth, with fine punctures. Both sexes have a horn on the head, but that of the female is much the smaller, and both sexes feed and cut burrows in the palms in which they remain in the daytime and fly about at night.

Suggestions for Dealing with these Beetles.

In dealing with this and allied lamellicorn beetles like the common Elephant Beetle of the Solomon Islands, we must remember that, unlike the red weevil, it is the adult beetle, and not the larva or grub, that does the damage to the Coconut palm. It is only in exceptional cases that the grubs are ever found in a palm tree. The beetle lays her eggs in the soil; or, when she can find a rotting stump, tree trunk, or decayed palm tree containing a more suitable vegetable mould for the larvæ to feed upon, she deposits the eggs in such situations in preference, but never in a healthy, growing Coconut palm. Therefore, all masses of decaying vegetable matter, if not burnt, should be turned over and spread about, so that they will not become breeding places for these big, white lamellicorn grubs. All decaying stumps and dead trees should be cleared off or examined, for, unless they are decaying, they are of no use to the grubs.

The beetles are large and fly about at night, so that they are not difficult to collect and destroy. A powerful lamp might attract them, as it does many other beetles.

The Red Palm Weevil.

(*Rhynchophorus ferrugineus,* Olivier.)

This is the common palm weevil of India and Ceylon, which infests the Coconut palm and the Toddy palm. Some writers have called it the Asiatic Palm Weevil, to distinguish it from *R. palmarum,* common in Brazil, Cayenne, Surinam, Honduras, and probably all along the tropical coast of South America. There is a third species, *R. cruentatus,* which destroys the date palms in Florida. In 1889 Ridley published a "Report upon the Destruction of Coconut Palms by Beetles in Singapore," in which he described the Red Palm Weevil and the Rhinoceros Beetle as the two beetles causing all the damage.

Fig. 6.
Side View, Red Palm Beetle.
Rhynchophorus ferrugineus.

In the Indian Museum Notes, 1891-1893 (Vol. 2), this beetle is figured, with an account of the damage it did to the Toddy palms in the Government Horticultural Gardens at Lucknow. In the same publication they are also recorded as being found in the stems of date palms imported from the Persian Gulf to the Saharanpur Botanical Gardens.

Lefroy says, in his work "Indian Insect Life":—

> The eggs are laid in the soft tissues at the base of the leaf-sheath at a wound or a cut made by the toddy-drawer; the larvæ tunnel through the tissue in all directions, and when mature make a cocoon of twisted fibres. This insect is one of the most important pests of India, and much has been written about it in Ceylon, where it is of still greater importance.

PLATE VI.

7, 9. Solomon Islands Stag-beetle. *Eurytrachelus pilosipes*, Waterh.
8, 10. Solomon Islands Stag-beetle. *Eurytrachelus pilosipes* (female).
11. Rhinocerous beetle from Samoa. *Oryctes rhinoceros.*
12. Red Palm Beetle. *Rhynchophorus ferrugineus*, Oliv.
13, 14. Longicorn Beetles. *Olethrius tyrannus*, Thoms.

Banks says that this "Asiatic Palm Weevil" is just as widespread in the Philippines, and a more serious pest to Coconut palms than the Rhinoceros Beetle, as it can enter the stem or leaf-stalk by a much smaller hole, and is therefore not so easily detected; and as the damage is done before it is noticeable, it is therefore a much more difficult beetle to deal with. This large weevil is variable in size and colouration, the larger forms measuring fully 1¾ inches in length in the Ceylon specimens, though Banks, speaking of the Philippine specimens, says "35 millimeters."

It is an oblong-oval weevil, with a long, slender snout characteristic of the grain weevil; the legs and under-surface are black, the upper or dorsal surface varying from dull red to dark brown, with several black dots on the thorax.

Though these colours are variable, the popular name of Red Palm Weevil, by which it is known in India and Ceylon, describes it much better than the proposed name of Asiatic Palm Weevil.

The grub is of the usual stout, thick-set form, without any legs, with a horny, brownish head furnished with jaws well adapted for gnawing vegetable tissue. When full grown they form a regular oval cocoon of the gnawed filaments of the stem in which they pupate.

Suggestions and Remedies.

When a tree becomes badly infested with this weevil, and there is no hope of its recovery, it should be cut out and burnt, so that all the larvæ and pupæ are destroyed. In dealing with the allied species (*Rhynchophorus cruentatus*) damaging the date palms in Florida, U.S.A., the editors of *Insect Life* suggested that trapping the beetles would be one of the most effective methods, and that, as these beetles are always attracted to injured trees, if several palms were cut down and left in the infested areas the beetles swarming to the decaying stumps could be much more easily collected.

Blandford, when dealing with another allied species (*Rhynchophorus palmarum*) in British Honduras, makes similar suggestions regarding the collection of the beetles.

The Sugar-cane Weevil.

(*Sphenophorus obscurus*, Boisd.; Voy. Astr., Vol. 2, p. 448.)

This is such a well known and widely distributed pest of the sugar-cane that I have listed it under the above name, though it has been recorded as attacking Coconut palms in a number of different countries. Many members of the genus, which is a very large one, breed in the stems of palms in their native forests, and two species are described from Australia. This particular species is supposed to be a native of Tahiti, from whence it was introduced in the stems of bananas into Oahu, Hawaiian Islands. It was found doing serious damage in the sugar plantations in 1888, when specimens were sent to Washington for identification, and an article was afterwards published in *Insect Life* (Vol. 1), "A Sandwich Island Sugar-cane Borer."

This weevil is probably a native of a very large area, including New Guinea, North Queensland, New Ireland, and the Solomon Islands, but may have been introduced into Fiji. To show the extent of the damage done in the cane-fields of Fiji in 1908, 6½ to 30 per cent. of the crop of sugar in Nausori, Rarawai, and Labasa was damaged. In the same year it was estimated that 8,000,000 beetles were caught at an expenditure of 3s. per 1,000 beetles at Labasa, and at Nausori it was estimated that 500,000 beetles were destroyed.

Habits.—The female enters beneath a loose leaf-sheath, making a narrow, curved passage in the stem to a depth of about one-eighth of an inch. Two or three such cuts having been made under cover of the leaf-sheath, she deposits her eggs therein, though sometimes they are simply deposited in the leaf-sheath. Sometimes they work round the base of the cane just under the soil, depositing their eggs half an inch beneath the surface.

According to Koebele and Terry's observations on the Hawaiian Island, the period of their life-history, from the egg to the adult beetle, is about three months. They remain in the larval state about sixty-five days, and in the pupal state about twenty-four days, though they cast their pupal covering and are developed beetles for nearly half that time before their bodies harden and they emerge. Therefore their development is very rapid, and as the female, under natural conditions, will live over a year, and is capable of laying eggs most of that time, one can understand how rapidly they can multiply.

The two methods adopted by the planters are, first, collecting the beetles under the sheaths, and, secondly, laying baits for them and then going round and collecting the baits and beetles. These baits or traps are simply split pieces of sugar-cane more or less decayed, which attract the beetles, and under which they remain for food and shelter.

In the Annual Report (1907) of the Hawaiian Agricultural Experiment Station, Van Dine says:—

> The following insects have been observed working on the Coconut palm:—The Cane-borer (*Sphenophorus obscurus*); the palm-leaf roller (*Omiodes Blackburni*); and the Florida red scale (*Chrysomphalus ficus*).

I have recently received specimens of this beetle and its larva, cut out of the trunk of a Coconut palm, which had been completely riddled by the larvæ. As this is a comparatively new plantation, it is probable that this beetle is a native of these islands.

Doane, in his "Notes on Insects affecting the Coconut trees in the Society Islands," says, speaking of *Sphenophorus obscurus*:—

> The larger larva usually works closer to the base of the leaf, often killing the leaf by burrowing all through it. Sometimes the larva will keep close to the edge of the leaf, or go only as far as the centre, boring a tortuous chamber from half to three-quarters of an inch in diameter. The burrow is usually filled with the chaff and castings, and the larva is usually found at the upper end of the burrow. Often from the blackened portion of the infested leaf the resinous exudation will be issuing in several places, making it appear that several larvæ are at work in the same leaf. This is sometimes the case, but a single larva may bore along a leaf stem for 12 to 15 inches, causing the exudation to flow in abundance from several openings, and making many large discoloured spots, beneath which the tissue is soft and decayed. The older leaves are usually attacked. After attaining its full growth the larva bores

close to the surface, and constructs a rude oval cocoon out of the fibre that it has been eating, and transforms to the pupa stage, from which it later issues as the adult beetle. These cocoons may usually be found quite abundantly in the chaff at the base of old leaves, or on the old leaves. In some instances the larva bores into the trunk of the tree for a short distance where the broad leaf base joins the tree. In one instance I found the beetle quite abundant in and around the growing tip of a young tree that was dying, whether as a result of the work of the beetle or from some other cause I was unable to determine.

The beetle measures slightly over half an inch in length from the front of the head (not including the curved snout, which is turned sharply downward) to the tip of the body. It is of the usual *Calandra* or palm-weevil type, with the slender snout and oval body. General colour, deep reddish brown, with the head and snout black, usually a slight black blotch behind the head, and a parallel stripe, often very well defined, running through the centre of the thorax; the upper surface of the thorax coarsely punctured, with the wing-covers thickly impressed with parallel striæ.

Suggestions and Remedies.

When a tree becomes badly infested with the larvæ of beetle borers of this class it is generally because there is something the matter with the tree. If this is the case the first loss is best, and if there is no hope of recovery it should be cut out before the beetles have emerged, and burnt.

It must be noted that, unlike the Rhinoceros Beetle, it is the larva, and not the beetle, that causes the damage to the palms. Therefore the thing is to trap the beetles and destroy them before they have laid their eggs, and it seems that the method adopted in Fiji on the sugar plantations could be adopted on the Coconut plantations with the same success, and a few stolls of sugar-cane could be grown on purpose for this work.

The Small Palm Weevil.

(*Calandra taitensis*, Guerin.)

This weevil was described by Guerin from the Island of Tahiti over seventy years ago, and does not appear to have spread like the larger weevil.

Doane found it more plentiful, and therefore a more serious pest to the Coconut palm in its native land, the Society Islands. He says:—

The smaller weevil, *C. taitensis*, seems to be much more abundant, and, on account of its habits, is perhaps more injurious than the larger species. It is found more commonly boring in the edge of the base of the leaf stem. Its presence is indicated, as with the larger species, by the presence of a gummy exudation mixed with castings. These are often in the shape of long twisted strings ¼ to ½ inch long. As the larvæ do not work so deep in the tissue of the leaf as do those of the larger species, the damage here is not very great, but when they work further out at the base of the leaflets, many of the leaflets are destroyed. A still more serious damage is done where the larvæ attacks the spikelets, killing them at the point of attack, and working towards the base.

After the larva has become full grown it makes for itself a rather long cell, with a very thin wall on one side, and, without making a cocoon, changes to the pupa, from which, later, the adult emerges and breaks through the thin wall of its cell.

The Leaf Hispa.

(*Brontispa Froggatti,* Sharp; Pro. Linnean Society, New South Wales, Part 4, p. 924, 1903.)

This beetle was first recorded by Mr. J. G. O'Mally from New Britain, who described it as a very serious pest on Kukada Plantation. He said when sending the writer the specimens for identification:—

> If something cannot be done to abolish or check this plague, I fear many thousands of acres of young palms will be destroyed. The beetle lays its eggs upon the young shoots of the plant, upon which the larvæ feed. There are fully 50,000 plants ravaged by this pest.

This beetle, which belongs to the great family *Chrysomalidæ*, containing most of our worst leaf-eating beetles, comes in the sub-family *Hispidæ*, which have two well-defined forms: short, thick-set beetles, covered with short spines; or slender, rounded beetles, with striated wing-covers. Though so different in general structure, they can be easily recognised by the antennæ, which are produced from the very front of the head, close together at the base, but spreading out to a sharp V at the tips.

The larvæ are all plant-eating grubs, many of them burrowing in the plant tissue, among which they feed and pupate. This beetle was sent by the writer, for determination, to Dr. David Sharp, of Cambridge University, who, finding that it was an unknown species, named it after the sender.

Since the record in 1903 this beetle has been found to have a much wider range, and is now only too well known throughout the Coconut plantations of most of the islands of the Solomon Group.

This beetle is a native of New Britain and the Solomon Islands, where it breeds upon the Coconut palms. When the forest land was cleared, and thousands of acres of Coconut palms planted, it turned its attention to them, with the result that, with such an abundant supply of suitable food, it multiplied so rapidly that it is the most serious Coconut pest in the Solomon Islands.

The beetle measures up to half an inch in length from the tip of the antennæ, which stands out in front, to the tip of the body; but they are often much smaller and variable in size, and are very slender, not more than one-tenth of an inch across the broadest part of the back.

The general colour is shining black, with the thorax and fore pair of legs dull yellow, and the second pair marked with yellow. The head is small, the eyes project on the sides, the front is produced into a lance-shaped point standing out between the basal joints of the stout antennæ. These antennæ consist of eleven short segments, the basal ones irregularly rounded, the apical ones cylindrical and fitting close into each other. The thorax is almost square, slightly hollowed out on the sides, and curved round in front behind the eyes. The long, slender body is covered with stout, black wing-covers, deeply and finely marked with parallel furrows, which are finely and deeply punctured, so that the whole surface is finely but regularly pitted. The tips of the wing-covers are depressed and rounded.

The beetles crawl into the folds of the opening fronds as they are expanding, and under their shelter lay their small, horn-coloured eggs, from which the curious flattened larvæ hatch and feed upon the surface of the leaf. Both the beetles and larvæ damage the leaves, and the whole life-history of the pest can be studied in a single frond. The larva, when full grown, measures just two-fifths of an inch in length; it is slender, cylindrical, and somewhat flattened, with the segments well defined. It varies in colour from dull horn-yellow to dirty white. The head is small, lobed, with short jaws on the under-side of the head; the small legs are divided at the extremities, forming two rounded feet. The abdominal segments, eight in number, are furnished on the sides with a slender, rounded, fleshy tubercle; and the anal segment has the tips flattened and produced into a pair of short, incurved, flat, caliper-like processes, which, curving inward, form a perfect crescent between them. They are ornamented with a few warty tubercles and fine hairs.

As the leaves of palms infested by this pest unfold they show the greater part of their tissue dead and rusty red, and where infested palms are neglected and the beetles and their larvæ are abundant, they soon become stunted and unhealthy, with the fronds covered with brown, dead leaflets instead of bright green.

Among the young Coconut palms where the beetles are numerous a gang of boys (kanakas) have to be constantly going over the terminal fronds, "beetling." The boys generally work in pairs, and, if the palms are well grown, are provided with a short ladder, so that the man can reach above the frond as he opens it out, while with the other hand he shakes some tobacco and soap wash out of a beer-bottle through a perforated cork on to the pests exposed to view. The liquid, running down the folded leaflet, kills all the beetles and larvæ it touches. The boys soon get very expert at this work, and the advantage of the bottle with the perforated cork over a sprayer is that very little wash is wasted.

The mixture used is composed of the leaf-stalks of tobacco, sold in Sydney at about £2 per ton, and Sunlight soap. The stalks are boiled down, and three tablets of Sunlight soap are added to each 12 gallons of tobacco wash. The cost of 40 gallons is estimated at 1s. 6d. to 2s.

This seems to be the most effective and cheapest wash that can be used, but it is not so much the cost of the material as it is the number of boys that have to be taken away from the other work of clearing and planting when labour is so scarce. Where the young palms had been recently planted out, the boys cleaning up the weeds as they went round the young trees, sprinkled a handful of ashes over the crown of every infested tree. A mixture of lime and tobacco-dust might be tried; one kerosene-tin of tobacco dust to four tins of lime, thoroughly mixed before it is shaken over the smaller palms.

This is certainly the worst pest the planters on the Solomon Islands have to fight in their young Coconut plantations, but as the trees grow up it is probable that they will suffer very little from this beetle pest.

The managers of several of the infested plantations have recently commenced cutting off the tips of the infested fronds as soon as they show signs of the presence of the beetle larvæ. They find that this stops the pest from spreading downward, and the shortened frond expands in a green, healthy state, without becoming reinfested. If this continues it will be a much cheaper and more rapid way of dealing with the leaf hispa than washing and scraping each infested frond.

The Copra Bug, or Red-legged Ham Beetle.

(*Necrolia rufipes*, De Geer.)

This cosmopolitan little scavenger beetle is well known in England and the United States under the popular name of the "Red-legged Ham Beetle," and though it is very partial to hams, where it may often be noticed sheltering in the crevices, it feeds upon all kinds of dead animal matter, such as sheep-skins, bones, and the remains of dead birds and animals upon the ground. The beetle is under a quarter of an inch in length, is slender in form, with the head rounded and the antennæ thickened to the extremities. It is of a dark bluish colour, with a metallic tint, and the legs are distinctly reddish.

Howard describes the maggot thus:—

> Its larva is a slender worm, and is at first white, with a brown head and two small hooks at the end of the body. As it grows older it becomes darker, and when full grown is greyish white, with a series of brown patches above. It is then rather more than one-half of an inch in length, and transforms within a paper-like cocoon. From the appearance of this cocoon the insect has become known as the "paper worm" to dealers in hams and dried meats.

Banks notes that this beetle is found attacking the copra in the Philippine Islands.

Most of the island boats trading from Sydney and bringing copra, which is chiefly packed in old corn-sacks for transit, swarm with these beetles, which crawl up the ventilators and other openings leading up from the hold. As they often crawl down one's neck and nip with their small but sharp jaws, the sailors call them "copra bugs." They are very abundant about the drying sheds on all the places I visited in the Solomon Islands, and where the dried copra is kept some time after it has been cured and ready for shipment, these beetles and their larvæ do a considerable amount of harm by gnawing and feeding upon the copra, and soon reduce the weight. They could best be controlled by fumigation with bisulphide of carbon under a tarpaulin.

Longicorn Beetles collected in the Solomon Island Plantations and destroyed.

During the clearing and planting of new land numbers of large wood-boring beetles are found, and, as a matter of policy, the managers of the plantations pay the boys for collecting them and bringing them in with the elephant and stag beetles. Several of these are figured, as they are destructive forest insects if they do not attack the Coconut palm.

(*Xixuthrus costatus*, Montrz.)

This great, greyish-brown longicorn beetle measures 3½ inches in length and 1¼ across the back, while the spread of its stout legs in front covers over 6 inches. The thorax is irregularly roughened, with four small knobs in the

Fig. 7.—Larvæ of Great Longicorn Beetle.
Xixuthrus costatus, Montrz.

centre and the outer edges finely serrate. The wing-covers are distinctly ribbed or ridged with three parallel lines, and contracted along the outer edges; the hind margins rounded, with a fine tooth on the inner edge. The front pair of legs are very large, and finely-toothed along the outer margin.

A number of these beetles were obtained on one of the plantations on the Russell Island Group. The great, fleshy grubs cut out of a tree are believed to be the larvæ of this beetle.

Another species has been described from Java.

(*Olethrius tyrannus,* Thoms.)

This is the large, reddish-grown, prionid longicorn, found all through the Solomon Islands and the New Hebrides. It varies very much in size and colour, the latter sometimes reddish to almost black, while in size they range from 2¾ inches to 1¾ inch in length. The legs are stout, and the basal joints of the antennæ thickened. The upper surface of the thorax is roughened, with two small, flattened, shining patches in the centre. The wing-covers are smooth and shining. The large, white larvæ feed and pupate in the trunks of trees.

Monohammus, Sp.

This handsome, brown, long-horned beetle was very plentiful in the Russell Islands, the boys finding them sheltering on the trunks of the papaw tree (*Carica papaya*), which has been introduced and has run wild along the edges between the forest and cleared land.

The Coconut Phasma.

(*Graeffer* (*Lopaphus*) *coccophagus,* Newport.)

This leaf insect was described by Newport, under the name of *Alopus coccophagus,* as a Coconut palm pest in 1844 ("Philosophical Transactions," p. 288). In Westwood's Catalogues of the *Phasmidæ*, 1859, it was placed in the genus *Lopaphus,* while Brunner described it as a new species from Viti-Levu, and placed it in the genus *Graeffer* in 1868.

In Brunner's Monograph, 1908, six species are included in this group from the Malay Archipelago and the Pacific Islands. This species has a very wide range, according to Brunner, being found in New South Wales, New Caledonia, Caroline Islands, Cook Islands, Tonga, Samoa, Solomons, and the Marquise Islands.

Wyatt Gill, in his "Jottings from the Pacific," Zoological Notes, gives a wood-cut of this insect, and a very interesting account of the damage it does to the Coconut palms on the Hervey Islands. It feeds exclusively upon the foliage of the palm, and in spite of its large size, over 7 inches in length, its adaptive colouration harmonises so closely with the green of the under-surface of the palm leaf to which it clings all day (feeding at night), that it escapes observation until the damaged foliage reveals its presence. They are at times so numerous that, after a storm passing through a plantation, the ground will be literally covered with the number blown out of the palms.

Gill says:—

An invasion of these voracious insects is almost as much dreaded by the islanders as a plague of locusts in the East. I have seen immense groves of Coconut palms destroyed in a few months by this species of phasma. Great

fires are sometimes lit by the natives underneath the trees, in the hope of smoking them to death, but with little advantage. It seems inglorious that a palm which has braved the storms of a century should eventually succumb to an insect. The phasma begins its ravages on the long leaves, and ends with the crown, when the palm, of course, dies.

The male, as usual in these orthopterous insects, is duller-coloured and smaller than the female; but while the male is of a uniform brownish tint, and the female deep green, both have delicate rose-coloured wings folded up under the narrow fore-wings or elytra. When handled they give out a very disagreeable odour common to many species.

We have in Australia a somewhat gregarious species, *Podacanthus Wilkinsoni,* which strip the foliage off large areas of the eucalyptus forests on the north-eastern coast of New South Wales, and appear every few years in countless millions.

Suggestions.

All the leaf and stick insects belonging to the family *Phasmidæ* have very similar habits. They feed upon different plants or trees, and bear colours that harmonise with the foliage among which they hide during the day, and upon which they feed at night; so that, in spite of their size, they may be quite numerous and pass unnoticed.

The female drops her remarkable, seed-like eggs (which are protected with a stout, hard shell from injury) upon the ground, where the may lie for months scattered about in the rubbish beneath the trees upon which the insects have fed; then, when favourable conditions come round, the tiny larvæ hatch out and make their way up the branches of their food-plant. Where they are known as a pest, in cultivated plantations, the ground might be burnt over, or turned over with a cultivator, by which means the bulk of the eggs would be destroyed. A bandage of sticky material, such as is used in America to stop the canker-worm from getting up the apple-trees, might be fixed round the trunks of the palm-trees, and the young phasmids thus kept from getting into the foliage. A funnel-shaped strip of tin or zinc could be fitted round the trunk in the same manner; this would not only act as a preventive to keep them out of the tree, but also as a trap, where they could be killed in thousands. When they are once found among the foliage of trees of moderate height it would be no difficult matter to spray the palm foliage with paris green or arsenate of lead, so that the insects feeding upon the poisoned leaves would die.

In native plantations, where the trees are grown anyhow and are very tall, it would be impossible to do any spraying, but with a little trouble the insects, when they are young and wingless, could be kept out of the trees.

Locusts and Grasshoppers.

In many places in the tropics, as soon as the forest is cut down and burnt off, grass and weeds appear as if by magic, and soon cover the cleared land with a thick mat of vegetation, which, if not cleared away round the young palm trees, would very soon smother them. This rank growth of grass is one of the difficulties with which all tropical cultivators have to deal while

their young trees are growing; afterwards the bigger trees will absorb the moisture from the surrounding soil, and under their immediate shelter there will be little or no grass.

With this growth of grass the many locusts and grasshoppers that are found round the edge of the forest, wherever grass and herbage grows, rapidly increase in numbers, and often become so numerous that they do considerable damage to the foliage of the Coconut palms growing on the grass-land. In the Solomon Islands the writer noticed that several species were very abundant, and had nibbled many of the young palms, though there was abundance of grass all round.

In the third annual report of the South African Locust Bureau, 1909, speaking of Mozambique, C. W. Howard says:—

> The loss of leaves to the sugar-cane is very serious, while the Coconut suffers not so much by mere loss of foliage as by the fact that leaves so eaten usually die next season, and, falling from the tree, leave the bunches of Coconuts without any support. These fall while quite green and useless, and in this way half to two-thirds of the crop may be a dead loss. The past season, from one-third to two-thirds of the Coconut crop from about 910,000 bearing trees, has been lost, as a result of damage done by locusts the two previous years. This has meant a loss of at least £75,000 to the planters. As an example of the loss caused to the sugar-planters, I may state that one plantation of 2,700 acres was expected to make 4,500 tons of sugar in the season of 1906-1907, but was able to produce only 1,800 tons, because of the presence of locusts. This means a loss of 2,700 tons, valued at £24 per ton.

Suggestions and Remedies.

The best way to deal with the grasshoppers would be to poison them before they have reached the flying stage and are able to attack the foliage of the palms. In a Coconut palm plantation poisoned food could be easily spread underneath the trees, which would be readily devoured by the young hoppers. The food could be either spread out on the ground, or dipped in the mixture and then spread out. Any green fodder, such as grass, young maize, sugar-cane, sorghum, or vetches could be used.

The most simple arsenical spray, as used both in South Africa and Australia, is—

White Arsenic Solution.

White arsenic (arsenious oxide), 1 lb.
Soda (washing soda), 1 lb.
Sugar or treacle, 2 to 4 lb.
Water, 17 gallons.

Boil the arsenic and soda together in a kerosene-tin, with 2 gallons of water; when dissolved, add the sugar, dissolved in the rest of the water, making the whole up to 17 gallons.

The Coconut Mealy-wing.

(*Aleurodicus cocois,* Curtis.)

After the great hurricane in 1831 the Coconut palms in Barbados were so badly infested with a "white fly" that not only the flowers and young nuts, but the leaves, fell off the infested trees. Specimens were sent to Curtis, who

described the insect under the above name in the *Gardener's Chronicle* (2nd May, 1845). In a note in "Insect Life" (Vol. 5, p. 314, 1893), the editors, after calling attention to this palm pest, state that it has been found in Trinidad damaging the guava, and warn the growers of gauvas in Florida to take all precautions to keep it out of their gardens and orchards. The Aleuroyds are closely allied to the tree scale-insects, but both males and females make tests upon the leaves and are furnished with wings.

As this insect has not been recorded as a Coconut palm pest since the time that it was described by Curtis, it cannot be looked upon as a very serious danger.

While collecting in the Solomon Islands in 1909, I noticed a palm on one of the plantations rather badly infested with a species of "snow fly," forming a black test with a fringe of white waxy filaments, but the only injury it seemed to cause was the blackening of the leaflets with fumagine.

Scale Insects—Coccidæ.

A great number of scale insects have been recorded from different parts of the world as infesting Coconut palms, with more or less serious results to their host; but, with one or two exceptions, it does not appear that the planter, with ordinary precaution, has much to fear from scale insects on a plantation run on commercial lines. Banks has described seven species, most of them new, from the Coconuts of the Philippine Islands; Doane, three from the Society Islands; and Cockerell, fifteen in the West Indies. However, with one or two notable exceptions, very few of these species do any serious harm to the trees; some of them are rare, and others only infest the Coconut in common with many other host plants.

I therefore propose to give a list of the species, only dealing in detail with those that are actual pests.

List of Coccidæ of the Coconut Palm, recorded by different writers, but many of which are also found upon other plants, and have probably little to do with the palms.

1. *Aspidiotus destructor*, Sign. This is the worst scale insect found in the palm; described further on, after the list.
2. *Aspidiotus lantaniæ*, Sign. Ann. Soc. Ent., France, p. 124, 1869. Mauritius, Galapagos, and Brazil. Upon Lantana, Coconut, &c.
3. *Aspidiotus cydoniæ punicæ*, Ckl. Journ. Int., Jamaica, p. 125, 1893. Jamaica and Dominica. Upon Coconuts and pomegranates.
4. *Aspidiotus articulatus*, Morgan. Ento. Mo. Mag., p. 352, 1889. West Indies, S. America, Mexico, and W. Africa. Upon Coconuts and many other dissimilar trees.
5. *Aspidiotus palmæ*, Ckl. Ento. Mo. Mag., p. 40, 1893. West Indies. Upon Coconuts and bananas.
6. *Chrysomphalus* (*Aspidiotus*) *personatus*, Comst. 2nd Report, Cornell Univ., p. 63, 1883. West Indies, Mexico, British Guiana. On Coconut and many other plants and trees.
7. *Chrysomphalus* (*Aspidiotus*) *Aonidum*, Linn. 1758. *Aspidiotus fici*, a well-known palm scale, is identical with this. Cosmopolitan, on many trees and plants. Coconuts in the West Indies.

8. *Chrysomphalus* (*Aspidiotus*) *aurantii*, Musk. T. N.Z. Inst., p. 199, 1878. Another cosmopolitan species, the red scale on oranges, &c., &c. In Ceylon on Coconut palms (Green).
9. *Diaspis boisduvalli coccois*, Licht. Bull. Soc. Ent., France, XXXVI., 1882. Found in France and Jamaica on Coconut palms.
10. *Diaspis vandalicus*, Galvez. Brunner, Insect Life, vol. 2, p. 278, 1890. Said to come from Cuba on Coconut palm leaves. This is a doubtful and uncertain species.
11. *Fiorinia fiortiniæ*, Farg. Studii sul. Cocc., p. 14, 1867. A cosmopolitan species, described by Green under the name of *F. palmæ*, on coconuts in Ceylon.
12. *Pinnaspis* (*Aspidiotus*) *buxi*, Bouchi, Stett Ent. Zeit XII, p. III, 1851. A West Indian species, described by Comstock under the name of *Mytilaspis pandani*. Coquillet describes a variety *Pinnaspis buxi*, var. *alba*, upon the Coconut in Trinidad, 1894.
13. *Vinsonia stellifera*, Westw. Pro. Ent. Soc., London, 1871. West Indies, S. America, California, and Ceylon. Found upon orchids, mango, other plants, and Coconut palms.
14. *Ceroplastes actiniformis*, Green. Indian Mus. Notes, p. 8, 1896. Ceylon, on Coconut palms.
15. *Coccus* (*Lecanium*) *acutissimum*, Green. Indian Mus. Notes, p. 10, 1896. Ceylon. On leaves of Coconut and other palms.
16. *Pseudococcus* (*Dactylopius*) *cocotis*, Musk. T. N.Z. Inst., p. 149, 1889. China, Fiji, and Laccadive Islands. On Coconut plams and hibiscus.
17. *Pseudococcus* (*Dactylopius*) *voigatus*, Ckl. *The Entomologist*, XXVI, p. 178, 1893. Jamaica, Sandwich Islands, Mauritius, Mexico, and Texas. Coconut palms, cotton, violets, cactus, &c.
18. *Lepidosaptus* (*Aspidiotus*) *gloveri*, Pack. "Guide to Study of Insects," p. 527, 1869. Doane records this scale as infesting the old foliage of the palms at the Society Islands, but doing little damage.
19. *Pseudococcus pandani*, Ckl. Psyche VII, Suppl. 1, p. 16, 1895. Washington Islands, Marquesas Group, upon pandanus. Doane records it as a pest on Coconut palms, Society Islands.
20. *Hemichionaspis* (*Chionaspis*) *aspidistræ*, Sign. Ann. Soc. Ent., France, p. 434, 1869. Almost cosmopolitan, upon many different trees; orange, orchids, ferns, palms, mango, &c. Doane records it upon Coconuts, Society Islands.
21. *Hemichionaspis* (*Chionaspis*) *minor*, Mask. T. N.Z. Inst., p. 33, 1884. New Zealand, Japan, Ceylon, Brazil, W. Indies, Panama, and Florida. Upon many dissimilar things—cotton, pepper, orange, fig, Coconuts, and many other plants.
22. *Aspidiotus* (*Aonidiella*) *coctiphagus*, Marlatt. U.S. Tech. Series, No. 16, Part 2, 1908. Bureau of Entomology, p. 14, pl. 2, Figs. 1 and 2. Massed on the upper surface of the leaves of Coconut palms. Santiago las Vegas, Cuba (Horn, W. T.).
23. *Asterolecanium lineare*, Lindinger. Jamb. Hamb., Aust. XXVI, 1908. In Brazil, upon Coconut.
24. *Furcaspis oceanica*, Lind. Beitschr, f. win. Insektenbiol, v. 5, p. 149, 1909, Figs. 7 and 8. Jaluit Islands, Marshall Group. On fruit hulls of the Coconut.

The following other scales are given by Banks as found in the Philippine Islands upon Coconut palms, 1906:—

Chrysomphalus propsimus, Banks. Philip. Journ. Science, p. 230, pl. 1-11.

Parlatoria Greeni, Banks. Philip. Journ. Science, p. 232, pl. IV, 1-5.

Chionaspis candida, Banks. Philip. Journ. Science, p. 232, pl. IV.

Lepidosaptis McGregori, Banks. Philip. Journ. Science, p. 233, pl. V, VI.

Lepidosaptis unicolor, Banks. Philip. Journ. Science, p. 234, pl. VII.

The Transparent Coconut Scale.

(*Aspidiotus destructor*, Sign.)

This scale insect was described by Signoret, from specimens sent to him from Reunion, where he says: "This species does great damage to the Coconut groves of this island. It is found on palms and dates."

Banks says:—

Aspidiotus destructor is by far the most pernicious of the scales which attack the Coconut in the Philippines. It most frequently occurs on young trees having from one to five years' growth, in many cases completely covering the under-surfaces of all the leaves, giving them a characteristic yellow tinge.

He notes that it is attacked by two parasites, a chalcid wasp and a ladybird beetle, and he describes the latter.

Doane says, in his notes on the scale in Tahiti, that—

It is one of the greatest pests upon Coconut palms in the Society Islands. Here it infests both old and young trees in a similar manner, but upon the old trees, besides the foliage, it spreads over the flower spikes, and even the Coconuts become coated with the scale.

Many trees have been killed, while others, on account of this infestation, bear no nuts, and on some of the islands it has become so bad that no nuts are gathered. At one time it appeared as if all the trees would become barren, as all the young palms became smothered with scale from the older infested trees.

Before his visit, however, a chalcid wasp parasite, identified as *Aspidiotiphagus citrinus*, which Doane thinks has been accidentally introduced with the scale, began to increase so rapidly that it was spreading all over the islands, and was found wherever the scale existed.

This scale is known as the *Bourbon Aspidiotus in the* West Indies. Maxwell-Lefroy gives a brief description and wood-cut of the scale, and records it from Grenada, Carriacon, Barbados, Dominica, Montserrat, Antigua, Trinidad, Jamaica, and British Guiana. It has been further recorded from Cuba, Ceylon, and the Laccadive Islands, so that it is almost cosmopolitan in its range, and may be expected wherever Coconut palms are found.

This is probably the worst scale insect that attacks the Coconut palm, and therefore planters opening up new country should be on the look-out for this pest, and see that they do not introduce it into their estates from other places, for it infests even the Coconuts in the Society Islands, and could thus be introduced with seed nuts. It might be described as a small, pale yellow to almost white, flat and circular, thin, papery scale, with a pale yellow central spot. Often so closely packed that they overlap each other,

these scales form a flaky crust. Under this tiny white shield the adult female scale deposits the tiny larvæ, which, as the female dries up, develop and emerge, tiny, active, little lice-like creatures, ready to attach themselves to the palm and form fresh scales. The male scales, which are usually not so abundant, are more elongated, oval in form, and darker in colour.

Though the members of this group of scale insects (the *Aspidiotus*) are usually hard and horny, it contains some of the most destructive species known. This particular species is much thinner and lighter in texture than most species, and is therefore much more readily destroyed by unfavourable weather conditions and by the attacks by parasites. It is also more amenable to treatment with spraying or fumigation. Kerosene emulsion or resin-wash would be an effective spray to use, while fumigation might be resorted to in cases where a large number of small trees were infested.

The Yellow Coconut Scale.

(*Aspidiotus oceanica,* Lindegner.)

This scale was described from the Jaluit Islands, Marshall Group, on the fruit hulls of the Coconuts, under the name of *Furcaspis oceanica.*

Green, in the Journal of Economic Biology, 1910, figures and describes it under the old generic name of *Aspidiotus.* He says "the insect closely resembles, and is indeed very nearly allied to, *Aspidiotus cladi,* of Maskell." The latter is an Australian species which covers the leaves of the sedges (*Xerotes*) about the coast lands, and is also recorded from Natal and Mauritius.

After giving a teachnical description, he says:—

Habitat—On fronds of the Coconut palm (*Cocos nucifera*), Yap, Caroline Islands. The insects are crowded upon the upper surface of the fronds, and scattered more sparingly on the under-surface on each side of the mid-rib. . . . The specimens were submitted with a note to the effect that "the Coconut estates of the South Sea Islands are suffering enormously from the ravages of an insect which endangers (according to scientists) all the Coconut plantations of the Caroline Island, Yap."

Mr. Green has received no information as to the age or size of the palms said to be so badly infested.

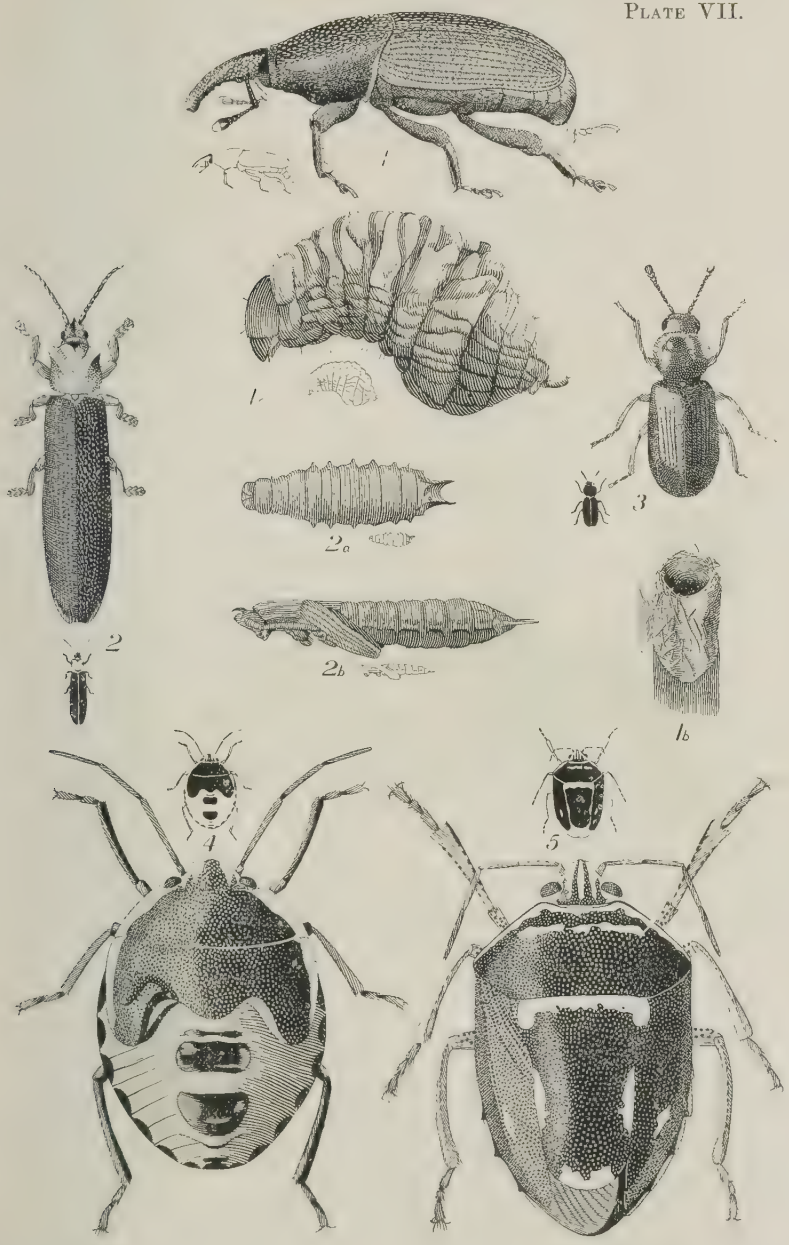
Remedies and Suggestions.

If the damage is confined, as is most probable, to the smaller palms, it would not be difficult to spray the fronds, without injuring the tree, with kerosene emulsion, red oil, or resin wash. In some places, where the ground is clear of grass and dead logs and the trees under 10 feet in height, it should be as cheap, and more effective, to tent and fumigate the palms.

Insects Attacking or Infesting the Flowers and Fruits.

The Coconut appears to be comparatively free from destructive insects when flowering and fruiting, though when the male flowers burst out in bloom they attract a number of flies, bees, and wasps; but these are more beneficial than otherwise, as they help to distribute the fine, dust-like pollen from the male fingers on the fingers bearing the tiny female nuts, and aid in their fertilisation.

PLATE VII.



1. Sugar-cane Weevil. *Sphenophorus obscurus*, Boisd.
1*a*. Larva. 1*b*. Pupa case.
2. Leaf Hispa. *Brontispa Froggatti*, Sharp.
2*a*. Larva. 2*b*. Pupa.
3. Copra Bug. *Necrolia rufipes*, De Geer (introduced).
4. Coconut Flower-bug. *Pentatominæ* (immature).
5. Coconut Flower-bug. *Pentatominæ* (adult).

Some beetles, however, may feed upon and damage the flowers, and small moths might be expected to develop the same habit; but it is among the plant bugs that we should look for pests that may puncture the flowers or young nuts or their stalks, and cause them to wither and drop off. I can find no record of plant bugs having been noticed doing such damage in other parts of the world, but while at Gizo, Solomon Islands, a planter informed me that there was a large shield bug (family *Pentatomidæ*) on some of his

Fig. 8.—Giant Longicorn.
Nixuthrus costatus, Montrz.
(Supposed to damage palms, Solomon Islands.)

palms which he considered to be the cause of many of the immature nuts dropping. I subsequently found this bug infesting a native palm on the edge of the forest, and later on found them in all stages of development swarming over the flowering palms on one of the plantations, but there was no apparent damage from their presence. Still this bug is worth watching, for if it developed the habit of puncturing the young coconuts or the stalks of the young nuts it might become a very serious pest. *Smoke* will often drive these pests out of other trees and plants, and might be applied in the case of coconut-bugs.

Minor Insect Pests of the Coconut Palm.

Under this heading I propose to briefly notice insects that have been recorded as infesting palms. Most of them are easily destroyed, and often perhaps only make their way on to the Coconut palm in search of food when their natural food-plant is scarce.

Banks describes two species of *Lepidoptera* from the Philippines as sometimes damaging the foliage. The first is the Coconut Skipper (*Padraona chrysozona,* Plotz), a small butterfly, the larvæ of which feed upon the leaves, and, when full grown, roll up a frond and pupate in its shelter.

The second he calls the Coconut Slug Caterpillar, which is the legless, spiny larva of *Thosea cinereamarginata,* Banks. Banks also gives an account of several beetles—the Shot-hole Coconut weevil, the Bonga weevil, and the Four-spotted Coconut weevil—which had not been identified when he published his paper, all of which are found damaging the Coconut palm in the Philippines.

In Blandford's paper on the Palm Weevil there is a note that one of the Stag Beetles (*Passalus tridens*) has caused much damage to the Coconut palms in Demerara. This is also noted in Ferguson's "All about the Coconut."

White Ants (*Termites*).—It is not an uncommon thing in the Solomon Islands to find one of the large, rounded, black "negro-head" termite nests constructed on the stem of one of the older Coconut palms, with the covered galleries running down from the nest to the ground, connecting them with the galleries below. This white ant belongs to the genus *Eutermes,* but has not been specifically determined. The nests constructed on the stems do not appear to cause any damage, but should be removed and burnt, for the termites may attack the roots. In Ceylon, while the termites sometimes damage the roots and trunks of the old palm-trees, it is the freshly-planted nuts that they are said to most damage, getting into and devouring the husk and destroying the developing plant.

Burning all white ant infested stumps, and destroying their nests in a similar manner, will soon reduce the numbers of white ants. These insects are usually found in the drier patches of the soil, and where they attack the freshly-germinating nuts it might be advisable to dip the nuts just before planting in water in which a little gas-tar has been dissolved. German potash (kainit) will also keep them away from the roots of fruit-trees.

In the "Agricultural Pests of India," Balfour says that:—

Batocera ruber, the "curumunga" beetle of Ceylon and Southern India, penetrates the trunks of young Coconut trees near the ground, and deposits its eggs near the centre. The grubs, when hatched out, eat their way to the top, and destroy the leaf. Sometimes whole plantations are attacked.

It appears as if he had confounded this large longicorn with the red weevil of Ceylon, the real culprit.

The Coconut Crab.

(*Birgus latro.*)

This large crab, often a foot in length, also known as the "Robber Crab," is confined to the Indian and Pacific Islands. It has been described by many naturalists, and most of its remarkable habits, doubted when stated by the earlier writers, have been confirmed by later observations.

It is allied to the hermit crabs, which, having no protective covering on the abdomen, used the dead bivalve shells for the purpose. This giant hermit crab, however, has the body protected with horny plates, and lives in a deep burrow lined with Coconut husk, coming out at night to feed upon coconuts. It strips the husk from the nut with its stout claws, and then,

Fig. 9.—Coconut Robber Crab. *Birgus latro.*

inserting the claw into the eye-hole, it breaks a piece out of the shell, so that it can insert the smaller claws into the hole and scrape out the kernel, upon which it feeds. Some writers say that, after getting the large claw into the eye-hole, it beats the nut against the ground until it breaks it. It was stated by the early explorers and naturalists that the Robber Crabs climbed up the Coconut palms, and, cutting off the nuts, threw them down on to the ground, which they afterwards husked and ate them. In most places where nuts are plentiful upon the ground it is probable that the crabs do not climb, and it is hardly possible that such a large crab could climb up a perfectly smooth, upright old palm tree; but they could easily ascend a leaning tree, or a young tree just in bearing, where the stem is thick and rough. In some places they climb the palms, while on other islands they appear to be content with fallen nuts.

Darwin, Forbes, Guppy, Wyatt Gill, and others have written upon the habits of the Robber Crabs.

Dr. Guppy, in his "Solomon Islands" (page 321), deals with them from an economic point of view, and says:—

We had on board H.M.S. "Lark" a *Birgus* that consumed on an average two Coconuts in three days. A number of these crabs in a Coconut plantation might therefore prove a considerable pest, for if this betokens the quantity of food which a *Birgus* consumes in a state of Nature, a single crab, in the course of twelve months, would dispose of 250 Coconuts, which represents the annual production of three trees, and between 20 to 30 quarts of oil.

Guppy says that they are common on many of the Solomon Islands, and he has found them at an elevation of 300 feet above the sea-level.

Wyatt Gill ("Jottings on the Pacific," 1885) gives a woodcut of a Robber Crab, and, after describing how the natives capture these crabs on the coral reefs of Manihiki and Rakaanga at night, gives a most remarkable account of the way in which the crabs deal with the Coconuts. He says:—

A number of Robber Crabs will sometimes climb a Coconut tree laden with fruit, and throw down every edible nut. Those below at once set to work to husk the fallen nuts. An ordinary-sized Robber Crab will finish the husking in the first night, reserving the feasting upon the contents for the second

Photo. W. W. Froggatt.

Fig. 10.—Young Coconut Palm coming into bearing, Lunga, Solomon Islands.

night. But a large and powerful crab will in one and the same night husk the nut, and then, breaking off a small bit of the hard shell in the neighbourhood of the monkey's eye, so as to get a firm hold of it, deliberately break it on a stone and quietly enjoy the feast.

But what about their friends on the crown of the Coconut palm? They usually reserve to themselves a nut apiece, husking the same in their ærial abode, and then break off the shell bit by bit with their pincer claws, till able to get at the rich kernel.

The abdomen is full of oil, and is much prized by the natives as an article of food. It is probable that the fondness of the natives for Coconut Robber Crab is a great factor in checking the undue increase of this crab; but when we remember how rapidly the natives are dying out in most of the Pacific Islands, it is probable that when this check is removed the crabs will soon increase in numbers, and may become a serious pest.

ANIMALS AND BIRDS THAT DAMAGE COCONUT PALMS.

Rats of various species are common in most tropical plantations. In Jamaica, Morris describes them as such a pest that galvanized-iron was cut in strips and fastened round the trunks of the trees to prevent the rats from ascending.

The Bandicoot Rats and the Porcupine are looked upon as pests in Ceylon by the planters, but while the latter retires before civilisation the former increase, sometimes in enormous numbers.

In several places in the Solomon Islands rats have been introduced with goods, and not only swarm in the houses, but are met with all over the plantations; but up to the present they have not been recorded as doing any damage to cultivated trees.

The fruit-eating bats, known in Australia as Flying Foxes, are said to be pests to palms in the West Indies; and as they congregate in enormous multitudes in gorges and valleys, where they sleep during the day, coming out at night to feed upon the forest fruits, if they once attacked Coconuts they would be a very serious pest to deal with. They do not, however, appear to have damaged any of the Coconuts in the village groves, and are not likely to invade the new plantations in the Solomon Islands and New Guinea.

A suggestion was made by someone in the Solomon Islands to introduce rabbits into the new plantations to keep down the grass. It is to be hoped, for the planters' sakes, that such a suggestion will be never carried out, for let rabbits become once established among the broken coral and rugged hillsides, and each plantation would soon become one huge rabbit warren, and rabbits, forming burrows under the roots of the palm trees, would cause them to blow over with the first wind-storm.

In the Solomon Islands there is a small white cockatoo, with a blue ring round the eyes and a very small crest, that gnaws holes in the small green Coconuts, and where numerous would do a great deal of damage. It would not, however, be a difficult matter to get rid of a bird of this size by systematic shooting.

BACTERIAL AND FUNGUS DISEASES.

Besides the many insect pests recorded, there are also three very important diseases that should be noticed, having a wide range over the coconut-growing area, and if neglected often causing widespread destruction on the plantation. These have been investigated in the West Indies by F. A. Stockdale, Mycologist to the Imperial Department of Agriculture for the West Indies, and T. Petch, Mycologist to the Royal Botanic Gardens, Ceylon, while other investigations have been made in Cuba by Dr. W. T. Horne, and in India by Dr. Butler.

The fungus diseases are not very serious enemies if the land is suitable and the trees are not neglected. Speaking of the leaf-disease, Stockdale says:—

> It has been noticed that the disease at present is doing serious harm only when the condition of the soil is unfavourable to healthy plant growth, and therefore, in order to keep the Coconut palms in vigorous growth, such points as drainage, manuring, and cultivation should be attended to.

Another important thing is that all decaying vegetable matter on the ground or on the surface should be cleaned up and burnt, or rendered unfit to be the host of resting fungus spores. All diseased trees, unless very lightly attacked, should be carefully removed and burnt; for not only are they a centre of infection by the dissemination of spores and bacteria by the wind, the birds, or insects, but they may breed serious insect pests for the surrounding trees. Whenever a tree becomes impoverished, from any cause, all boring insects seem to have an instinctive knowledge of the fact, and come to feast and lay their eggs on this suitable tissue. Many trees presumed to be destroyed by insects have been already in a dying condition before the insects assisted in their destruction.

Leaf Disease of the Coconut.

There is no country where palms are found growing in the natural forest, indigenous to the island or mainland, where one cannot find more or less evidence of fungi attacking the foliage. There are probably many undescribed species that will develop under favourable conditions upon cultivated Coconuts when they are planted upon freshly-cleared land, or near the edge of the still remaining forest.

These fungus attacks generally appear as grey or brown spots or blotches, sometimes of a bright rust-red colour, and may increase in size and run into each other, or remain circular spots and dry out in the centre, forming a hole. This phenomenon has given some allied forms that attack our fruit trees the name of "shot-hole" fungus, the holes being left in the leaf when the fungus has "burnt" itself out.

Leaf diseases of this kind seem to be common among the palms in the Solomon Islands, chiefly upon the young trees, but where the growth is vigorous they do not seem to affect the health of the tree, and as the growth of the stem lifts the leaf fronds higher and higher above the damp ground,

so favourable for the development of spores, they appear to throw off the leaf-rusts of their youth. Therefore I think that all the ordinary leaf-rusts can be easily controlled on most plantations.

There has, however, been a very serious leaf disease described under the name of *Pestalozzia palmarum* from Java, and the same, or another closely-allied form, has been investigated in the West Indies, where it kills the infected palm. The leaves become so badly infected that they are completely destroyed; the nuts become less and less in number, and then the flowers do not even set. Finally the terminal bud becomes so exposed that it dies and rots away.

Bud Rot of the Coconut Palm.

This was for many years one of those abscure diseases that specialists could not definitely ascribe to a fungus or to bacteria. It is now, however, considered to be the latter. Petch says:—

> The organisms responsible for the decay are bacteria, which are found in abundance in the rotting tissues. They are short, thick rods, with rounded ends, which form whitish colonies of slow growth on sugar agar. A second form is described in the West Indian bud-rot, but this has not been observed in Ceylon specimens. These bacteria appear to find an entrance to the cabbage along the youngest leaf; it is supposed that they develop at first in the sweet, slimy coating found on all the young protected organs.

This disease has been known in the West Indies for over thirty years, but little notice was taken of it until the creation of an Agricultural Experiment Station in Cuba after its occupation by the United States, when it was discovered that a great number of the older Coconut palms were dying out from a disease that was afterwards proved to be bud-rot; and it was calculated that unless something was done to check it, within less than twenty years the Coconut palm industry would have vanished.

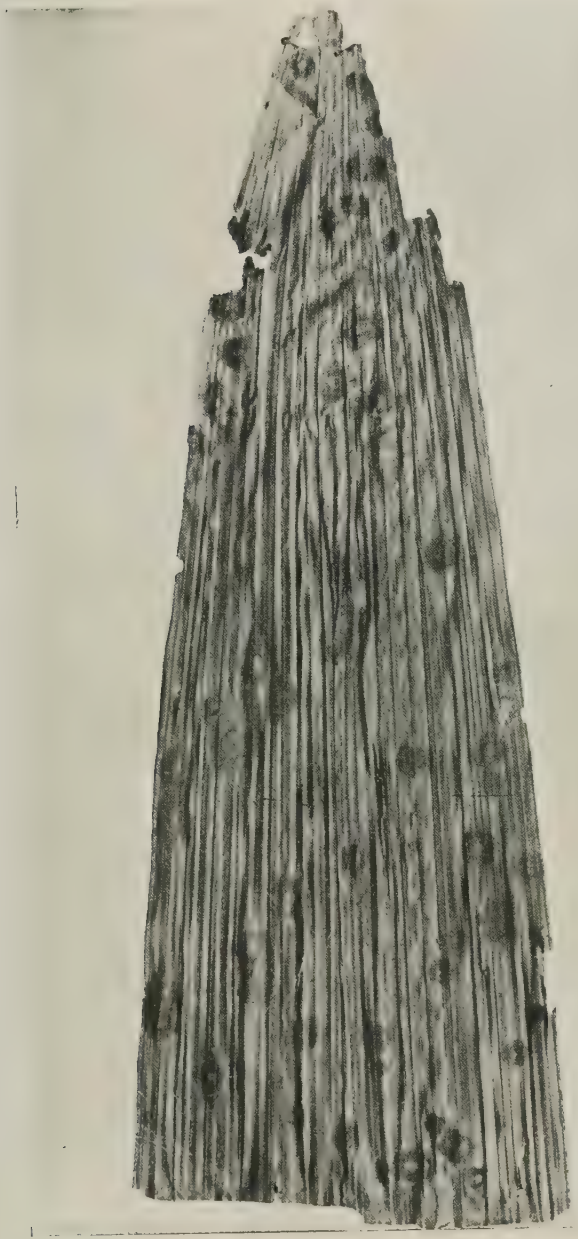
Under the heading "Coconut Bud-rot in Jamaica," in the *Agricultural News* of Barbados, W.I. (January, 1911), a statement is made that the Governor has had his attention drawn to the state of this disease, and he is asked to issue a proclamation enjoining all growers of coconuts to cause all diseased palms to be destroyed, and that compulsory legislation may be passed to this effect, at the next session of the Legislative Council.

Experiments were being carried out at the Station at Santiago de Vegas when the writer was visiting the scientific staff (1907). Dr. Horne said that it was chiefly confined to the south-eastern district, and that probably one of the reasons of so much disease among the palms was that for the last twenty years, on account of the unsettled condition of the country, very few new trees had been planted, and those growing had been neglected.

A case of bud-rot was recorded from Portuguese East Africa in 1903. Petch (Circular Agr. Journal, 1906) says:—

> It seems certain that bud-rot has existed for a long time in the Eastern Tropics, though it has seldom caused widespread damage. A case was brought to the notice of the Department early in 1906. The specimen submitted consisted of the upper part of the stem, capped by a dark-brown, soft, foul-smelling mass, which represented the "cabbage." Its close resemblance to the West Indian bud-rot was very evident, and a visit to the locality confirmed the supposition that we had to deal with the same disease.

PLATE VIII.



Original Photo. from Botanic Gardens.

Leaf Rust of Native Palm, Solomon Islands.

This disease takes its popular and appropriate name from the fact that the decay set up by the bacteria commences at the flower-bud or the terminal leaf-bud. The flowers, while in a very immature state, are most liable to attack, but sometimes the "cabbage" (the central bud of the whole tree) is the first point of attack, while the palm is in full bearing and shows no signs of disease. When the flower-bud is attacked the disease spreads along the stalk of the adjacent leaf, causing it to turn yellow; then extending along the leaf-stalk it reaches the terminal bud, and the tree is doomed.

Stockdale ("Fungus Diseases of Coconuts in the West Indies"), speaking of the symptoms by which the disease can be recognised in the field, says:—

> The youngest leaves stand upright, and do not unfold as they should. Afterwards they turn yellow, and then brown, in colour, and the whole appearance is that of a withering tree with the centre of the cabbage in an unhealthy condition. Sometimes the dying of the central bud could not be noticed until many of the lower leaves had turned yellow or brown; nor did there appear to be any regular succession of deaths of the lower leaves, for often the lowest leaves were the first to turn yellow, while at other times the middle leaves showed the first signs of being unhealthy.
>
> After a time the terminal bud falls over, frequently leaving a ring of quite healthy-looking leaves at the top of a headless trunk. A badly-diseased bud is generally full of fly larvæ, &c., and the smell is awful.

When a tree becomes unhealthy and shows any similar symptoms, in a new plantation in particular, it should be cut down and burnt, and the hole in which it has been planted cleaned out and treated with lime and filled in with fresh soil before a new tree is planted in its place.

A tree that has died of bud-rot, if left in the middle of a plantation, is a centre of infection to the surrounding palms. Many insects are attracted to the fermenting, rotting stem; and, feasting upon it, fly to healthy trees, and thus infest the clean flowers or fronds with the germs they carry.

In Cuba the natives firmly believe that a large water-bug (*Belostima*), which flies about at night, is the real cause of bud-rot in their palms, and, in an indirect manner, their idea may be correct.

Dr. Butler, Imperial Mycologist to the Government of India, in a report published last year (Memoirs of the Department of Agriculture in India) states that the Indian bud-rot disease is caused by *Pythium palmivorum*, one of the *Phycomycetes*, and therefore a true fungus disease and not bacterial. He is of opinion that some of the forms of this disease found in other parts of the eastern tropics will prove to be identical with this fungus, if the forms in the New World are due to other organisms. He gives a very full account of the symptoms of the disease and its effect upon the different kinds of palms attacked—Palmyra, areca, and date palms, as well as the coconut; for all these species suffer over an area of 25 miles in the richest part of the Madras Presidency, where the disease was investigated.

Root Disease.

The following is quoted from Stockdale's report—a plain description of the appearance of trees affected by this fungus disease:—

> An attack of this disease is generally first shown by the leaves. They show a slightly wilted appearance, then turn yellow, first at the tips and then gradually all over the leaflets. These dry up, blacken, hang down from the "cabbage,"

and often remain for a considerable time before they are shed—a badly attacked palm often being entirely enclosed in numbers of leaves around its trunk. Frequently, however, it is noticed that the leaves do not hang down around the trunk, but the petioles break across, leaving the sheathing portion on the trunk, while the foliage portions of the leaves have fallen to the ground. Sometimes the petiole does not completely break, and the foliage portion of the leaf hangs vertically downwards, attached to the portion of the petiole that is left attached to the stem. The outer leaves are sometimes those that show signs of wilting and yellowing first, but this is not always so, for frequently palms may be noticed in which a "middle" ring of leaves become wilted and yellow, while rings of green leaves remain above and below.

After the yellowing of the leaves, trees bearing a good crop of nuts, as a rule, gradually shed most, if not all, of them, irrespective of their size and stage of development, and the flowers subsequently produced do not set. In fact, it is possible for a person to pick out, with certainty, trees that are diseased before any yellowing of the leaves is noticed by carefully looking at the condition of the leaves, and at the latest flowers that are being put forward.

Young trees are not attacked as a general rule, but trees just coming into bearing often are. Stockdale points out that the excessive strain on the tree in producing the crop weakens the powers of resistance to disease.

The disease is rapid, often killing the tree within three or four months, and the spores will soon spread so that a patch of a dozen or more trees will soon denote an infested area if the diseased or dying tree is neglected. Root-disease is known in Trinidad and British Guiana, where Stockdale investigated it. Butler has described it, or a very closely allied fungus, from Travancore, India.

There appears to be no cure or check for this disease, and it is probable that several diseases are confounded under the name of "root-rot." The writer saw an example in a plantation in the Solomon Islands, where several trees in a somewhat low-lying spot on the land had developed very unhealthy conditions. This may have been caused by defective drainage, or by the different nature of the soil. It is probable that where the native forest is cut down, and the plantation started among the stumps and decaying trunks, the soil is full of fungi and bacterial germs, some of which may be easily transmitted to the young palms in the new plantation.

LIST OF PAPERS AND REPORTS MENTIONED IN BULLETIN.

1. Baker, Sir. S.
Eight Years in Ceylon, 1874, p. 207. A general account of the Coconut Palm.

2. Balfour, Surgeon-General C.
The Agricultural Pests of India; London, 1887, pp. 30, 43, 107, 118.

3. Banks, C. S.
The Principal Insects attacking the Coconut Palm; Philippine Journal of Science, Vol. 1, Nos. 2 and 3, 1906; with many illustrations; pp. 143-167, 211-236.

4. Bennett, Dr. G.
Wanderings in New South Wales, Batavia, Peder Coast, Singapore, and China, being the journal of a naturalist in these countries during 1832-1834. Vol. 1, p. 405; Vol. 2, Appendix. The Coconut Palm; pp. 295-342. London, 1834.

5. Blandford, W. F. H.
The Palm Weevil (*Rhynchophorus palmarum*) in British Honduras; its life-history, habits, and economic features. Reprinted Kew Bulletin, February-March, 1893; pp. 27-60. With two plates, and notes on other pests.

5a. Butler, Dr. E. J.
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Department of Agriculture,
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